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FAA AVIATION FORECASTS, FISCAL YEARS 1990 - 2001: THE AIR CARRIER FLEET

The U.S. commercial aviation industry has now entered into the fourth phase of the deregulation process – Globalization. This, combined with other "free market" movements around the world, most notably the proposed deregulation of the European Common Market by December 1992, opens the possibility of the creation of multi-national "megacarriers" throughout the world. Some have predicted that there will only be a dozen world airlines by the 21st century. The race among the world's air carriers is now on to see who can put together the most effective global system. These strategies include marketing agreements, "code sharing," and/or equity stakes in other carriers. What this portends for the commercial aviation industry is open to conjecture. One thing is certain, however: the airline industry worldwide will continue to exhibit strong growth rates well into the 21st century. Also, the U.S. experience with code-sharing agreements between the large air carriers and regionals/commuters suggests that the smaller carriers benefit from working relationships with the larger airlines. In future years, the same could hold true for competition in international markets.

Over the past two years, world airlines placed a total of 2,936 orders for large jet aircraft with U.S. and foreign aircraft manufacturers – 2,204 of these orders occurred in 1989 alone. Of this two-year total, 1,744 (75.1%) were for two-engine narrow-body aircraft (Boeing 737 and 757, McDonnell Douglas MD-80, and Fokker F-100). As of September 30, 1989, aircraft manufacturers had a total backlog of 3,059 aircraft on order. Of this total backlog, 2,318 (75.8%) were for two-engine narrow-body aircraft. U.S. customers have ordered a total of 1,236 aircraft over the past two years – 795 in 1989 alone. Of this two-year total, 84.6% (1,046 aircraft) were for two-engine narrow-body aircraft.

Also, over the past two years, aircraft manufacturers delivered a total of 1,073 jet aircraft worldwide – 560 aircraft in 1989 alone. Of this two-year total, 757 (70.6%) were two-engine narrow-body aircraft. Deliveries to U.S. customers totaled 466 over the past 2 years – 215 in 1989 alone. Of this 2-year total, 80.5% (375 aircraft) were two-engine narrow-body aircraft.

It is important to note that aircraft deliveries to U.S. customers over the past two years were, for all intents and purposes, net additions to the U.S. fleet. Very few of the older Stage 2 aircraft have been retired during this time period. If this trend continues, it will put intense pressure on both the Air Traffic Control and the National Airspace Systems.

At the end of fiscal year 1989, there were approximately 2,304 Stage 2 aircraft in the U.S. air carrier jet fleet. Because of the projected slowdown in passenger demand in 1990, it is anticipated that U.S. air carriers will begin to retire or sell the older Stage 2 aircraft. For purposes of FAA forecasting, a 25-year life cycle has been assumed for most Stage 2 aircraft, the exception being those aircraft considered likely for retrofit. At the end of the 12-year forecast period, it is projected that there will be approximately 849 Stage 2 aircraft remaining in the U.S. airline jet fleet. (This assumes no mandatory phase-out of Stage 2 aircraft by the year 2000, as is currently being considered.)

Based on the backlog of aircraft orders and the projections of air carrier traffic, seat capacity, passenger load factors, and fleet retirements, the U.S. commercial air carrier fleet is projected to increase from an inventory of 3,870 large jet aircraft in 1989 to 4,949 aircraft by the year 2001. This assumes the delivery of almost 214 aircraft annually, and results in the net addition (after retirements) of approximately 90 aircraft (2.1%) to the U.S. fleet each year. Over the next two years, a total of 463 aircraft are expected to be delivered to the U.S. commercial airline fleet.

To absorb this expected increase in capacity in 1990 and 1991, and still maintain the high passenger load factors, significant reductions have been assumed in the utilization rates of the older Stage 2 aircraft. Conversely, the industry could decide to maintain current utilization rates and allow passenger load factors to decline below 60.0%, or decide to retire even more Stage 2 aircraft than we are predicting.

By far, the largest increase, in terms of number of aircraft, is projected to occur in the two-engine narrow-body aircraft category, which is expected to grow by an average of 96 aircraft (4.3%) annually. By the year 2001, two-engine narrow-body aircraft are expected to total 2,912 units and to account for 58.8% of the total fleet, up from 45.6% in fiscal year 1989. This trend reflects the fact that the continued expansion and development of hub airports increases the importance of higher frequencies and the demand for aircraft with smaller capacities.

Three-engine narrow-body aircraft (Boeing 727), the mainstay of the air carrier fleet during the 1970's and early 1980's, are expected to decline from 1,191 aircraft in 1989 to only 488 aircraft in the year 2001. The number of four-engine narrow-body aircraft (McDonnell Douglas DC-8, Boeing 707, and British Aerospace BAe 146) is also expected to decline in absolute numbers over the forecast period, from 257 in 1989 to 107 in the year 2001.

Wide-body aircraft, which accounted for only 17% of the U.S. air carrier large jet fleet in 1989, are expected to account for 29.2% of the fleet by the year 2001. Two-engine wide-body aircraft (Airbus A300 and A310, and Boeing 767), the fastest growing of all the aircraft groupings, are expected to increase by an average of approximately 40 aircraft (11.1%) annually, from 187 aircraft in 1989 to 661 aircraft in the year 2001.

The second fastest growing aircraft category are the four-engine wide-body aircraft (Boeing 747 and Airbus A340), which are expected to increase from 171 aircraft in 1989 to 362 by the year 2001, an annual increase of 6.4%. The three-engine wide-body category (McDonnell Douglas MD-11 and DC-10, and

Lockheed L-1011) is projected to grow from 300 aircraft in 1988 to 419 aircraft in the year 2001, an average annual increase of 2.8% (10 aircraft).

These forecasts of air carrier demand are based upon a specific set of assumptions, not the least of which are the economic and political climates in which they take place. There are a number of developments or events taking place which, depending upon the outcome, could drastically alter the short- and/or long-term environment and cause the results to be significantly different from those forecast.

Some of the economic and political developments having the potential to alter the forecast results include:

- **the "perestroika" (restructuring) process currently underway in the Soviet Union and the subsequent general easing of tension between the U.S. and Soviet Russia;**
- **the possibility of large cuts in the U.S. military budget;**
- **the political upheaval now taking place among Eastern Bloc countries;**
- **the "tearing down" of the Berlin Wall and the potential for reunification of the two Germanies;**
- **the economic deregulation of the European Economic Community scheduled to take place in 1992 and the impact that changes in Eastern Europe and Germany will have on this process.**

In addition to the above, the network of bilateral pacts that the U.S. currently has in place in Europe, the Far East, and South America could inhibit the massive expansion of planes of air carriers operating in these international regions and restrain traffic growth.

(Excerpted from "FAA Aviation Forecasts, Fiscal Years 1990-2001," Report FAA-APO 90-1, available through the National Technical Information Service, Springfield, VA 22151.)

INTERNATIONAL CIVIL AVIATION

The following is extracted from remarks made by M. Craig Beard, Director of FAA's Aircraft Certification Service, at the opening of the CAA/FAA joint airworthiness management seminar on December 5, 1989, in Singapore:

The international civil air transportation system that has evolved over the past sixty years will do more to promote a more friendly and peaceful world than just about any other activity of man. Civil aviation, and civil aviation alone, provides a means for people of different cultures, from different regions of the world, to get to know each other, and to better understand each other by facilitating both trade and tourism on an international scale. Predictably, thanks to the services of our international civil air transportation system, the day may actually come when "foreign countries" no longer exist on planet earth. A day when peoples of different countries can, through personal contact, gain a better understanding and greater respect of their different cultures – learning to see their differences not as something to be feared or threatened by, but rather something that adds to the quality of life.

If civil aviation is to satisfy its full potential, the civil aviation safety regulatory authorities of the world – and particularly of the predominant manufacturing countries – must work in close cooperation, not in competition in our development and application of safety regulations.

Nobody wins if any one country or consortium of countries were to abandon cooperation in favor of competition in aviation safety. What criteria could you possibly use to judge the winner? All manufacturers that sell in the international market place must meet the requirements of all authorities taken collectively. So the goodness of one set of standards as compared to another will not make one country's or group of countries' products more or less safe than the others.

With emerging trends in international joint design and production, in aircraft leasing, in route interchange agreements, and with the compelling interest all owners and operators have in protecting the capital investments they have in aircraft and aircraft components, it is imperative that efforts toward international harmonization of aviation standards – in all areas – remain on the priority agenda.

NEW BILATERAL AGREEMENTS UNDER CONSIDERATION

Negotiations are underway on new bilateral airworthiness agreements. The new bilaterals are modeled on the recently signed agreement between the U.S. and Canada, which introduced several innovations recognizing the increasingly international nature of aircraft design and production.

New versions have been sent to England, France, Germany, the Netherlands, Sweden, Spain, and Italy. Austria is negotiating an expanded bilateral based on the new model and Argentina is nearing signature of its first bilateral with the U.S. Representatives from Spain recently visited FAA Headquarters to discuss the language of the new version.

The Aircraft Certification Service will propose new bilaterals to the remaining countries of the Joint Airworthiness Authorities (JAA) of Europe. The FAA hopes that the new bilaterals can be in place when the European Economic Community lifts all trade barriers in 1992. Common bilateral agreements with the separate countries would facilitate the FAA's work with the new JAA organization that will be created at that time.

TRANSPORT CATEGORY FATIGUE TESTING CONCEPTS: FULL-SCALE FATIGUE TESTING

Many airplanes are designed to fail-safe concept, and new airplanes to the damage tolerant concept, as required by FAR Part 25. The FAA considers that the damage tolerant concept has provided the best basis for continued structural airworthiness. It has been successfully applied not only to normal fatigue cracking, but also to manufacturing flaws and accidental damage. Even so, and in spite of objections raised by some manufacturers, the FAA believes that an aircraft operated beyond its design life may reach a point where widespread multiple-site fatigue damage (MSD) could occur, invalidating the original expectations and principles to which the airplane was designed.

The potential for widespread MSD has long been one of the design considerations for transport category airplanes as noted in FAR Section 25.571(b). It was felt that protection against failure from MSD would be provided by a special structural inspection program. The inspection thresholds, techniques, and repeat intervals would be determined by a damage tolerance analysis of the most critical structural elements. Such programs (known as "Structural Inspection Document" programs, or SID's) have been developed for most transport aircraft, and the airlines have been required to comply with these programs by airworthiness directive (AD) action. In addition, some manufacturers have added special fail-safe design features, such as bonded tear straps and skin "flapping," which would allow certain failures to occur in a benign manner with minimum risk to passengers and crew. Experience has now shown that, while these inspections and design features do work as expected, they cannot be totally relied on to assure safety. MSD-related failures have resulted in loss of life and serious injuries to passengers and crew.

Methods for reliably predicting and detecting MSD are needed, and several studies are now underway to accomplish this. Detection, however, is hampered by the fact that MSD cracks are typically very small until just prior to link-up and failure. This small size, together with the very large areas that must be inspected, makes detection unreliable with today's techniques. Prediction is also difficult, but one method is known to work. That involves conducting a full-scale fatigue test on a representative airframe to well beyond the expected service life. If failure has not occurred during the test, the test article must then be torn down and carefully inspected to confirm or deny the onset of MSD.

The FAA has determined that the only practical means of managing this problem is to predict the onset of MSD by conducting full-scale fatigue tests. It remains, then, to establish the extent of that testing. The manufacturers design to an "economic design goal," typically considered to be the period of service after which a substantial increase in the maintenance costs could be expected in order to assure continued safe operation. For discussion purposes, this is stated in terms of a specific number of flights or flight hours.

For new designs with conventional metal structure, the concept under consideration would require full-scale fatigue testing for two lifetimes, followed by a teardown inspection to look for the onset of MSD. For airplanes in the current fleet, a margin of one lifetime above the high-time airplanes is considered necessary to ensure that MSD type cracking will not be a problem while the airplanes remain in service. Fatigue tests for the current fleet would preferably be conducted on a complete full-scale airplane which is approaching its design lifetime. However, this may not always be practical, or in some cases even desirable. Components taken from critical locations on the fuselage, wing box, and horizontal stabilizer box sections should be acceptable test articles. The test spectrum loads should represent the anticipated utilization over the projected lifetime of the model. The tests will not be considered complete until a teardown inspection has been conducted to identify incipient MSD.

Although most of the current fleet of turbojet powered airplanes have been evaluated for fatigue strength and subjected to full-scale fatigue testing, some were not subjected to two lifetimes of full-scale fatigue tests. Also, some of those that were fully fatigue tested have now exceeded their original design service life.

FAA Regulatory Concepts:

Notwithstanding the recommendations from many organizations, the FAA does not plan to require that safe-life retirement limits be established for transport airplanes. However, we do believe that if full-scale fatigue testing indicates that a point could be reached where widespread MSD is likely within the projected operational life of the airplane, then those elements subject to such damage should be modified or replaced. The current regulations already require the consideration of MSD. It is essential that full-scale fatigue testing be conducted well beyond the expected service life of the airplane. This will enable us to ensure that MSD-type damage will not occur during the operational life of the airplane.

We agree that fatigue tests are useful for locating areas on an airplane that may be subject to early cracking and for developing an economic design life for the airplane. However, we do not agree that this is the only reason that they are conducted or the only benefits that are derived from them. Recent cases, as well as past experience, indicates that full-scale fatigue testing aids in the prediction of unexpected cracking in new structures early enough to prevent failures in service. In addition, full-scale fatigue testing aids in the prediction of cracking in aging structures, including the development of widespread MSD brought about by scenarios not amenable to other types of evaluation.

The FAA considers that the only practical means of managing the MSD problem is to verify predictions of the onset of MSD by conducting full-scale fatigue tests for the equivalent of two times the design service life of the airplane. The FAA is, therefore, considering amending FAR Section 25.571 to require full-scale fatigue testing of primary flight structure to two times the design service life on all future designed transport category airplanes.

The FAA is also considering proposing a Special Federal Aviation Regulation (SFAR) to require fatigue evaluation of primary flight structure on the current fleet of aging turbojet-powered transport category airplanes used in air carrier service.

The FAA considered proposing standards that would place the responsibility on the manufacturer to assure that MSD will not occur for as long as the airplane remains in service. The type certification process is based on the expectation that the airplane manufacturer will provide design changes that contribute to the safety of the product. However, the operator has the ultimate responsibility to ensure that airplanes are properly maintained and safe for operation. Therefore, while the FAA recognizes that the airplane manufacturers normally perform the fatigue evaluation of airplane structure, this proposed SFAR would be applicable to airplane operators. The FAA expects that, even though this proposed regulation would apply to operators, the airplane manufacturers will support the efforts required by these standards.

The proposed SFAR would apply to all turbojet-powered transport category airplanes which, in their normal interior configuration, have a seating capacity of more than 30 passengers, or a maximum payload capacity of more than 7,500 pounds.

Both draft Notices of Proposed Rulemaking are currently under development in the FAA and are expected to be published in the Federal Register for public comment by January 1991.

Our position does not imply a shift away from fail-safe/damage tolerant design, but recognizes a need to supplement it with an additional means of assessing the possibility of widespread cracking in structures which may be operated well beyond their economic design life. We agree that fatigue testing to two lifetimes is no substitute for a diligent inspection program established by means of a thorough damage-tolerant evaluation. However, as an additional means of evaluating structures, full-scale fatigue testing can only result in an improvement in safety.

POLICY REGARDING IMPACT OF MODIFICATIONS AND REPAIRS ON THE DAMAGE TOLERANCE CHARACTERISTICS OF TRANSPORT CATEGORY AIRPLANES

All transport category airplanes having the damage tolerance requirements of FAR 25.571 (Amendment 25-45) as their certification bases, and those with mandated Supplemental Inspections Documents (SID) that were assessed to the damage tolerance requirements of FAR 25.571, must continue to maintain their damage tolerance characteristics when repaired or modified in any way. This includes all airplanes of a model, even though all the individual airplanes are not candidate airplanes or part of the sample set defined in the respective SID. Any modification which affects the loading spectrum, the stress levels, or the damage tolerance characteristics of the structure must be reassessed to determine its impact on the inspection program. In addition, this may require the development of additional inspection requirements for the modification.

Most of the current inspection programs are based on statistical sampling of Principal Structural Elements (PSE) in accordance with the manufacturer's SID. The statistical sampling is justified based on the assumption that the sample population is representative of the fleet and that the inspection methods will ensure continued airworthiness of the entire fleet. The SID programs are based on type design crack growth data generated from analysis or structural tests using a realistic and conservative loading spectrum, material properties, part geometry, etc. For this reason, structural modification that may increase stress levels in load carrying structures, including maximum weight limit increases, cargo door installations, and repairs to load carrying structures, must be reassessed for its impact on the structural inspection program. Also, modifications affecting the detail design, including geometry and material properties, must be reassessed to the damage tolerance criteria and adjustments made in the inspection program to ensure continued airworthiness.

In general, modified structure will not be represented by structure in the SID fleet; therefore, special inspections may be needed to ensure continued airworthiness of the modified airplane. Where the special inspections are required to ensure continued airworthiness, these special inspection programs become a part of the type design for the modified structure and must be incorporated into the maintenance programs. These inspections or procedures should be documented in accordance with the provision of the Airworthiness Limitations Section of the Instructions for Continued Airworthiness required by FAR 25.1529.

Where structures are modified under the approval of a supplemental type certificate (STC), any special inspection procedures must be included in the STC and made a part of the inspection program for that airplane. These inspections or procedures should also be documented in accordance with the provisions of FAR 25.1529. Special inspections on structures modified under the approval of an amended type certificate will be handled in accordance with procedures established for handling alternate type designs.

To provide widespread awareness of the application of the provision of this policy, this Directorate has asked the responsible TC issuing certification offices to add the following note to the TC Data Sheet on airplanes that have mandated SSIP programs:

> *"This model airplane has a mandated Supplemental Structural Inspection Program (SSIP). This program was prepared in accordance with the provisions of AC 91-56. Evaluation of structural elements, type of damage considered (fatigue, corrosion, service, and production damage) and the inspection and/or modification criteria should, to the extent practicable, be in accordance with the damage tolerance principles (Amendment 25-45) of the current FAR 25.571 standards."*

HIGH ENERGY RADIATED ELECTROMAGNETIC FIELDS (HERF): INTERIM POLICY GUIDELINES ON CERTIFICATION ISSUES

Following are the present policy guidelines to assure uniformity of HERF requirements for certification projects until a final rule can be issued.

FAA's Aircraft Engineering Division in Washington, D.C., Headquarters has initiated a regulatory project to add requirements for the protection of aircraft electrical and electronic systems from the effects of the HERF environment. An FAA all-Directorate team is coordinating this effort. The project is progressing on schedule and a Notice of Proposed Rulemaking (NPRM) is due to be published for public comments in October 1990. An associated advisory circular and a user's manual will be published at the same time.

Presently, for certification projects, special conditions are being applied to provide a level of safety in the HERF environment. Approvals based on these special conditions are to be reassessed for safety in view of the finalized rule requirements. The applications will be advised of the post-certification reassessment.

The HERF envelope to be used in the special conditions is revised based on new data and SAE-AE4R subcommittee recommendations. This revised envelope, represented by the following Table I, includes data from Western Europe and the U.S.

The following guidelines are to be used in the certification projects:

a. **CERTIFICATION PARTS 23, 25, 27, AND 29**: For new, amended, and supplemental type certificates under Parts 23, 25, 27, and 29, special conditions will be issued requiring that the applicant must comply with either (1) or (2), as follows:

(1) The applicant may demonstrate that the operation and operational capability of the installed electrical and electronic systems that perform critical functions are not adversely affected when the aircraft is exposed to the HERF environment, using Table I below.

TABLE I

FIELD STRENGTH VOLTS/METER

Frequency	Peak	Avg.
10-500 KHz	80	80
500-2000	80	80
2-30 MHz	200	200
30-100	33	33
100-200	33	33
200-400	150	33
400-1000	8.3K	2.0K
1-2 GHz	9.0K	1.5K
2-4	17.0K	1.2K
4-6	14.5K	800
6-8	4.0K	666
8-12	9.0K	2.0K
12-20	4.0K	509
20-40	4.0K	1.0K

Or,

(2) The applicant may demonstrate by a laboratory test that the electrical and electronic systems that perform critical functions withstand a peak electromagnetic field strength of 100 volts per meter in a frequency range of 10KHz to 18 GHz. When using a laboratory test to show compliance with the HERF requirements, no credit is given for signal attenuation due to installation.

In view of the revised HERF envelope, Table I, which was recommended by the SAE-AE4R subcommittee, the requirement for the fixed value test has been changed to 100 v/m from the previously used value of 200 v/m. The applicant opting for the fixed value laboratory test, in lieu of the HERF envelope, will be subject to post-certification reassessment based on the finalized rule requirements. The applicants should be cautioned that choosing 100 v/m may make it difficult to qualify, under post-certification reassessment requirements, the installations without design upgrade.

b. **COMPLIANCE METHOD.** This paragraph describes an acceptable method of showing compliance with the HERF requirements for new, amended, or supplemental type certificates.

(1) **Compliance Plan.** The applicant should present a plan to the cognizant FAA Aircraft Certification Office (ACO) for approval, outlining how the compliance with the HERF requirements will be attained. This plan should also propose a pass/fail criteria for the operation of critical systems in the HERF environment.

(2) **System Criticality.** A preliminary hazard analysis must be performed by the applicant for approval by the cognizant FAA ACO to identify electrical and/or electronic systems that perform critical functions. The term "critical" means those functions whose failure would contribute to, or cause a failure condition which would prevent continued safe flight and landing of the aircraft.

(3) **Candidate Systems for HERF Requirements**. The critical systems identified by hazard analysis are candidates for the application of HERF requirements. The primary electronic flight display and the full authority digital engine control (FADEC) systems are examples of critical systems. For approval of such systems, certification criteria of paragraph (a) should be used. A system may perform both critical and non-critical functions. The HERF requirements only apply to critical functions.

Primary electronic flight display systems and their associated components perform critical functions, such as attitude, altitude, and airspeed indication. Thus, the HERF requirements apply only to these functions. If redundant display systems are used, all systems should be subjected to test/analysis for the HERF requirements of paragraph (a).

The FADEC is another example of a system which performs critical functions, in this case, engine thrust control. Therefore, the HERF requirements apply to the FADEC, and all systems performing a critical function must be tested or analyzed for HERF requirements.

Since the defined requirements are based on a 500-foot altitude assumption, additional consideration should be given for functions that are critical for aircraft that operate below 500 feet.

(4) **Compliance Verification**. Compliance with HERF requirements may be demonstrated by tests, analyses, models, similarity with existing systems, or a combination thereof as acceptable to the FAA ACO. Service experience alone is not acceptable since such experience in normal flight operations may not include an exposure to the HERF environmental condition.

(5) **Pass/Fail Criteria**. Acceptable system performance is attained by demonstrating that the system under consideration continues to perform its intended function during and after exposure to required electromagnetic fields. Deviations from system specification may be acceptable and will need to be independently assessed for each application by the ACO.

(6) **Test Methods and Procedures.** Numerous documents, including RTCA-DO-160C, Section 20, and users' manuals, provide information on acceptable procedures.

Equipment and subsystem radiated susceptibility qualification tests should be conducted by slowly scanning the entire frequency spectrum with an unmodulated signal which produces the required average electric field strength at the equipment under test (EUT) and its wiring. A peak level detector should be used to monitor the peak values of the signal, and these values should be recorded at each test point. The EUT should not be damaged by this test and should operate normally for frequencies below 400 MHz. Deviations from normal operation for test frequencies above 400 MHz should be recorded. The test should be repeated with an appropriate modulation applied to the test signal. At each test point, the amplitude of the RF test signal should be adjusted to the peak values recorded during the unmodulated test. The modulation should be selected as the signal most likely to disrupt the operation of the equipment under test based on its design characteristics. For example, flight control systems may be susceptible to 3 Hz square wave modulation, while the video signals for CRT displays may be susceptible to 400 Hz sinusoidal modulation. If the worst case modulation is unknown or cannot be determined, default modulations may be used. Suggested default values are a 1 KHz sine wave with 80% depth of modulation in the frequency range from 10 KHz to 400 MHz, and 1 KHz square wave with greater than 90% depth of modulation from 400 MHz to 18 GHz. For frequencies where the unmodulated signal caused deviations from normal operation of the EUT, several different modulating signals with various waveforms and frequencies should be applied.

Modern laboratory equipment may not be able to continually scan the spectrum in the manner of older analog equipment. These units will only generate discrete test frequencies. For such equipment, the number of test points and the dwell time at each test point must be specified. For each decade of the frequency spectrum (a ten times increase in frequency, i.e., 10 KHz to 100 KHz) there should be at least 25 test points; and for the decades from 10 MHz to 100 MHz, and from 100 MHz to 1 GHz, there should be a minimum of 180 test points each. The dwell time at each test point should be at least 0.5 second.

(7) **Data Submittal.** An accomplishment report should be submitted to the FAA ACO in fulfillment of HERF requirements continuing test results, analyses, and other pertinent data as stated in the compliance plan.

c. **SUPPLEMENTAL TYPE CERTIFICATES (STC)**: These HERF policy guidelines should be applied to all STC applications received by the ACO's on or after December 5, 1989, if the proposed aircraft modification involves electrical and electronic systems that perform critical functions. This effective date is based on the consideration that the applicants should be advised of the HERF requirements in the early stages of the STC project.

For those STC's that are in process, and for those that have already been approved, a forthcoming Notice of Proposed Rulemaking (NPRM) will propose that all systems that are susceptible to the HERF environment that have not been previously tested be evaluated and, where necessary, tested to verify that they meet the HERF requirements. If this evaluation reveals a safety issue, corrective action will be needed.

d. **TYPE CERTIFICATES (TC) AND AMENDED TYPE CERTIFICATES (ATC).** For the approval of the TC's and ATC's involving electrical and electronic systems that perform critical functions, these guidelines are consistent with previously defined policy on HERF. That is, the special conditions should be used for the certification of aircraft that employ electrical/electronic systems performing critical functions. Therefore, a new effective date for HERF policy on TC's and ATC' is not necessary.

e. **CANDIDATES FOR HERF.** It should be clear that only those electrical/electronic systems that perform critical functions and are proposed for installation under a TC, and ATC, or an STC are subject to the evaluation for HERF effects. A preliminary hazard analysis is an acceptable method for determining critical function. For example, if an electronic display system performing a critical function, such as the attitude indication, is proposed for approval through an STC application, the HERF criteria only applies to the proposed installation that modifies the certified aircraft.

COMPLIANCE WITH CARGO COMPARTMENT LINER REQUIREMENTS OF FAR 121.314 AND 135.169(d)

The following is general guidance regarding compliance with cargo liner requirements for transport category airplanes operating in Part 121 or 135 service. This guidance is intended to help in determining if particular cargo liner design features require substantiation and to clear up some of the confusion concerning the new requirements for cargo or baggage compartment liners.

Part 25 of the FAR was recently amended (Amendment 25-60) to require the liners of Class C or D cargo or baggage compartments to meet new flammability standards. These new standards are contained in Appendix F, Part III, of Part 25. Because that amendment applies only to airplanes for which an application for type certificate is made after June 16, 1986, it was necessary to take further action for airplanes that were or will be manufactured under older type certificates. Parts 121 and 135 were, therefore, amended later (Amendments 121-202 and 135-31) to require operators of those airplanes to meet similar standards. As amended, both Sections 121.314 and 135.169(d) specify that the liners must be of glass-fiber reinforced-resin construction, must meet the test requirements of Part 25, Appendix F, Part III, or, in the case of previously approved installations, be of aluminum construction.

As in all rulemaking, the cost of compliance was carefully weighed against the benefits of the new standards. Although glass-fiber reinforced-resin construction does not always meet the flammability standards of Appendix F, Part III, tests have shown that it invariably comes very close. The cost of requiring operators of airplanes manufactured under older type certificates to literally meet the new standards was not considered to be justified by the small increment of additional safety that might be realized. Sections 121.314 and 135.169(d), therefore, permit the use of liners of glass-fiber reinforced-resin construction, without any further testing. This includes new or replacement liners as well as continued use of existing liners.

For most applications, the capability of glass-fiber reinforced-resin construction to meet applicable flammability standards is dependent on the specific resin used. In this case, the fabric of the glass-fiber acts as a flame arrestor even though the resin may have burned away. Compliance with Section 121.314 or 135.169(d) is, therefore, not dependent on the resin used for the compartment liners.

Again considering the cost of compliance and the small increment of safety that would be realized, Section 121.314 or 135.169(d) permits an operator to retain aluminum liners if the liner installation was approved prior to March 20, 1989. Because aluminum liners are generally not as good from a flammability standpoint as those of glass-fiber reinforced-resin construction, neither Section 121.314 nor 135.169(d) permits an operator to make a new installation of aluminum liners after that date.

There is no specific requirement stating that repaired liners have to meet the same flammability standards; however, there is a very definite implicit requirement that they must meet these standards. This is simply that a repaired liner of glass-fiber reinforced-resin construction would no longer comply with Section 121.314 or 135.169(d) if it had a repair that was not of glass-fiber reinforced-resin or equivalent. Similarly, an aluminum liner would no longer comply if, as repaired, it was not as good from a flammability standpoint as an unrepaired aluminum liner. Of course, repaired liners would always be acceptable from a flammability standpoint, regardless of the type of construction, if they were tested in accordance with Appendix F, Part III, and found satisfactory.

As far as determining if particular liner design features require substantiation, note that *complete* liner elements which are either aluminum or fiberglass are acceptable without test; however, *incomplete* aluminum or fiberglass liner elements, such as an air difuser grill, which are not backed by an acceptable material, will require substantiation. Liner elements which are not either aluminum or fiberglass will also require substantiation. This latter category may include design details such as light adapter rings, velcro-attached panels, heating outlet nozzles and non-metallic fasteners. Substantiation may take the form of an actual test (particularly in the case of zippers and non-metallic fasteners etc.) in a manner acceptable the to FAA.

Since Parts 121 and 135 allow the use of aluminum without further substantiation if it was an approved installation prior to March 20, 1989, the use of an aluminum sheet with several small holes (approximately .25") is considered equivalent in a sidewall application, if the sheet will not pass flame. The use of steel wire mesh as a sidewall liner may be acceptable for a particular installation provided the area behind the mesh is not susceptible to heat damage. While the mesh will act as a flame barrier, it will not prevent heat from damaging components behind and would not be acceptable as ceiling liner; therefore, the specific installation would require evaluation. Small smoke detector pick-ups of the type currently in use are acceptable without further substantiation.

Consideration should be given to the method of retaining blowout (decompression) panels; some latitude may be allowed in the retention means, provided the basic panels comply. Minor features in the retention means which do not pass the oil burner test may be acceptable if the basic panel complies and the failures of the retention means are localized, i.e. the entire panel is not compromised if a small part of the retention means fails.

With respect to sidewall-floor configurations, the regulation does not require that a "floor" be installed. However, it is required that the sidewall liner and floor plane intersect, such that there are no gaps vertically.

Areas in the vicinity of the cargo door opening mechanism should be lined to the extent practicable, although we recognize that some components will need to be exposed to enable free operation of the door.

If you have any further questions, contact your cognizant ACO.

DEFINITION OF CARGO OR BAGGAGE COMPARTMENTS (REF. FAR SECTION 25.857)

During the early post-World War II period, it was recognized that timely detection of a fire by a crewmember while at his station and prompt control of the fire when detected were necessary for protection of the airplane from a fire originating in a cargo or baggage compartment. Because the requirements for detection and extinguishment varied depending on the type and location of the compartment, a classification system was established. Three classes were initially established and defined as follows:

CLASS A - A compartment in which the presence of a fire would be easily discovered by a crewmember while at his station, and of which all parts are easily accessible in flight. This is typically a small compartment used for crew luggage and located in the cockpit where a fire would be readily detected and extinguished by a crewmember. Due to the small size and location of the compartment, and the relatively brief time needed to detect and extinguish a fire, a liner is not required to protect adjacent structure.

CLASS B - A compartment with a separate, approved smoke or fire detector system to give warning at the pilot or flight engineer station and sufficient access in flight to enable a crewmember to effectively reach any part of the compartment with a hand fire extinguisher. Because it has a smoke or fire detector system, it may be located in an area remote from any crewmember's station. Due to the potentially larger size of the compartment and the greater time interval likely to occur before a fire would be extinguished, a liner meeting the flame penetration standards of Section 25.855 and Part I of Appendix F of FAR Part 25 must be provided to prevent the fire from spreading to other areas of the airplane and to protect adjacent structure. As originally defined, there was also to be sufficient access to enable the crewmember to move all contents of a Class B compartment by hand; however, that requirement was subsequently deleted. Although Class B compartments are typically the large cargo portions of the cabins of airplanes carrying a combination of passengers and cargo (frequently referred to as "combi" airplanes), there are also Class B compartments that are relatively small baggage compartments located within the pressurized portions of airplanes designed for executive transportation.

CLASS C - As defined at the time of initial classification, any compartment that did not fall into either Class A or B was a Class C compartment. Class C compartments differ from Class B compartments primarily in that built-in extinguishing systems are required for control of fires in lieu of crewmember accessibility. Due to the use of a built-in extinguishing system and closer control of ventilating airflow, the distribution of extinguishing agent in a Class C compartment is considerably more uniform than in a Class B compartment. The volumes of Class C compartments in currently used domestic jet transport category airplanes range from approximately 700 to 3,000 cubic feet.

Later, two additional classes were established and defined as follows:

CLASS D - A compartment in which a fire would be completely contained without endangering the safety of the airplane or the occupants. A Class D compartment is similar to a Class C compartment in that both are located in areas that are not readily accessible to a crewmember. In lieu of providing fire or smoke detection and extinguishment, Class D compartments are designed to control a fire by severely restricting the supply of available oxygen. Because an oxygen-deprived fire might continue to smolder for the duration of a flight, the capability of the liner to resist flame penetration is especially important. The standards for Class D compartments were later amended (Amendment 25-60; 51 FR 18236; May 16, 1986) to limit the volume of those compartments to 1,000 cubic feet; however, some previously approved airplanes in air carrier service have Class D compartments as large as 1,630 cubic feet. Other airplanes designed for executive transportation, and also used in air taxi service, have relatively small (15-25 cubic feet) Class D compartments located outside the pressurized portions of the cabin.

CLASS E - A cargo compartment of an airplane used only for the carriage of cargo. In lieu of providing extinguishment, means must be provided to shut off the flow of ventilating air to or within a Class E compartment. In addition, procedures such as depressurizing the airplane are stipulated to minimize the amount of oxygen available in the event a fire occurs in a Class E compartment. Typically, a Class E compartment is the entire cabin of an all-cargo airplane; however, Class E compartments may be located in other portions of the airplane. This, of course, does not preclude the installation of Class A, B, C, or D compartments in all-cargo airplanes.

FIRE RESISTANT vs. FLAME PENETRATION RESISTANT MATERIALS

This Directorate has received a request for guidance in discerning the difference between *"fire resistant"* and *"flame penetration resistant"* materials.

The definition of a *"fire resistant"* material, as used in Part 1 of the FAR, is a comparison of the material's fire performance compared with aluminum alloy used for the same purpose. Under this definition, different materials may be considered *"fire resistant"* depending on their usage.

A *"flame penetration resistant"* material, as used in Appendix F, Part III, is one which passes the test criteria in that appendix (note that aluminum sheet must be approximately .25" thick in order to pass this test). In actual practice, most formulations of glass-reinforced resin material will pass this test; however, there may be some fiberglass materials which do not pass the 400-degree requirement. For the purposes of the retrofit requirements of FAR Part 121, it was determined that the relatively small percentage of fiberglass materials in service which may not pass the test were still superior to other materials in use and would require exhaustive testing to identify. Therefore, FAR Section 121.314 accepts fiberglass without test.

For the purposes of compliance with Section 25.855, Amendment 25-60, all materials, including fiberglass, will require substantiation. This would not preclude substantiation on the basis of similarity once satisfactory test performance has been obtained.

STOWAGE COMPARTMENT REQUIREMENTS OF FAR SECTION 25.787

Section 25.787 of Part 25 of the FAR requires that each stowage compartment, including those for cargo, baggage, carry-on articles and equipment (including emergency and galley equipment), must be designed to retain the contents at the appropriate load factors corresponding to the flight and ground load conditions and to the emergency landing conditions of Section 25.561(b). This regulation also requires stowage compartments in the passenger cabin to be completely enclosed, except for underseat and overhead compartments for passenger convenience. Amendment 25-64, effective June 16, 1988, increased the emergency landing conditions specified in Section 25.561(b) and added a rearward load of 1.5g.

The requirement to completely enclose stowage compartments is intended to provide more protection than that provided by restraint devices such as tie-down straps or webbing; therefore, these compartments should have doors. The completely enclosed requirement was not intended to apply to seat back pockets, literature pockets or small magazine racks, but applies to all equipment compartments. Fixed items such as ovens, coffee makers, and video equipment need not be installed in enclosed compartments. Galley carts, meal boxes, and tray carriers with their own doors are considered to be the enclosure. Emergency equipment is not required to be stowed in a compartment, but if installed in a compartment, it must be completely enclosed. Closets and other stowage units that are installed against the airplane sidewall may have a gap of up to one inch between the unit and the sidewall and still be considered enclosed.

Overhead stowage compartments for passenger convenience need not be completely enclosed, but should retain the contents under the conditions of Section 25.561 as revised by Amendment 25-64 or be limited to articles that will not become a hazard in an accident.

Underseat stowage is not considered to be a compartment and need not be completely enclosed. Baggage bars to retain articles in the forward and sideward directions should be installed. Footwells forward of seats are considered to be underseat stowage and should have equivalent restraint for stowed articles and should have weight limit placards.

THE USE OF A CREW-OPERATED SEAT RECLINE MECHANISM FOR SEATS AT TYPE III EXITS

The Transport Airplane Directorate has received requests for use of a mechanism that would allow the seats at Type III exits to be reclined (potentially into the exit opening) during flight, and subsequently inhibited for take-off and landing by a crewmember. We have seen this type of capability on airplanes which have been exported from the U.S. The provision has been allowed as an <u>exception</u> by the foreign airworthiness authority, however, and is noted as such on the certificate of export.

We do not consider such mechanisms acceptable for the following reasons. The relevant Federal Aviation Regulation, Section 25.813, requires that Type III exits be unobstructed by seatbacks in any position. We have interpreted this requirement to include any <u>possible</u> position of the seatback permitted by the design and have required seats with a recline capability to be positively inhibited by a device requiring a tool to alter. We also require such seats to be identified with a special part number or other suitable means of distinguishing them from other seats of the same model. Since Type III exits are usually remote from a flight attendant's station, there is an increased opportunity for the seat configuration to be changed after the flight attendant has secured it. In addition, the position of the seatback is a relatively inconspicuous indication and is more susceptible to being overlooked than, for example, a service cart which has been removed for inflight service.

If you have any further questions, contact your cognizant ACO.

FLIGHT ATTENDANT ASSIST HANDLES

The presence of assist handles to enable flight attendants to steady themselves when assisting in a passenger evacuation has long been a feature provided, but not required on transport airplanes. Assist handles can, however, be a significant contributor to the success of an evacuation in certain interior arrangements. In many cases, assist handles have been provided and utilized for conduct of full-scale evacuation demonstrations but subsequently not always provided on production installations. This Directorate considers that where an assist handle has been utilized for an evacuation demonstration, the production airplane should also have an assist handle.

We are initiating regulatory action to propose a requirement for assist handles at *all* floor level exits, regardless of the evacuation demonstration configuration; at this time however, to maintain the validity of the evacuation demonstration, existing installations substantiated *using* an assist handle should always be so equipped in production. The assist handle should be located at the designated flight attendant assist space(s) such that it serves as an effective hand hold.

Another aspect of this issue concerns the installation of assist handles whose purpose is to aid in door opening, and which may not be located at the flight attendant assist space. These handles can be confusing in that they may encourage a flight attendant to stand on the wrong side of the door and interfere with the passageway. In these instances, an assist handle should be installed at the assist space also.

We recognize that there may be existing installations which do not comply with this guidance. Each cognizant FAA office will be reviewing the installations for which it is responsible and ensuring that this guidance is being followed for future approvals.

MAXIMUM PASSENGER CAPACITY OF TRANSPORT AIRPLANES

The following guidance is provided as a result of ongoing certification projects as well as inquiries received by this office.

The maximum passenger capacity of a transport airplane, as listed on the airplane type data sheet, represents the maximum passenger capacity for which the airplane is eligible. There may or may not be an FAA-approved interior arrangement at the maximum capacity. The data sheet listing indicates that the airplane, as a type, is eligible to have such an arrangement installed. This basically means that compliance with the applicable FAR Part 25 sections concerning ditching [Section 25.807(d)], evacuation [Section 25.803(c) or (d)], and type and number of exit requirements [Section 25.807(c)(1) or (2)] has been shown for the capacity listed. Compliance findings pertaining to a particular interior arrangement have not been made unless there is an FAA-approved drawing or other specification which defines the arrangement. Conversely, even if there is one approved maximum capacity arrangement, a different arrangement for the same passenger capacity would require a separate approval.

When establishing the maximum capacity to be listed on the data sheet, consideration should be given to all relevant parameters. For example, if the exit-limited passenger capacity as defined in Section 25.807(c) has not been substantiated by compliance with the evacuation demonstration requirements of Section 25.803, the data sheet should reflect the evacuation limit and not the exit limit. Other limiting factors may be structural capability, seating density (uniform distribution of exits), or ditching exits. In any case, the data sheet should not list a capacity for which the airplane is not capable. When the data sheet limit is not the Section 25.807(c) exit limit, an additional note which briefly describes the reason for the limit is appropriate.

PROPULSION SYSTEM ELECTRONIC DISPLAYS

Most new transport airplane designs now incorporate electronic cockpit displays. Advisory Circular (AC) No. 25-11, dated July 16, 1987, provides guidance regarding the certification criteria to be used in approving these types of systems. Section 4 of the AC presents a brief description of the different types of displays and the acceptability of various failure modes.

Paragraph 4a(3)(ix) discusses propulsion system parameter displays. The material presented therein was based upon what was learned from the Airbus Model A320 design review, and most of the criteria came from the Model A320 special condition concerning propulsion system displays. Upon further review, the Transport Airplane Directorate now considers some of the criteria presented in paragraph (ix) of the AC too specific and should be revised to be more objective according to the current airworthiness standards (FAR Part 25). Below is our proposed revision to paragraph 4a(3)(ix):

"(ix) PROPULSION SYSTEM PARAMETER DISPLAYS.

(A) Propulsion system parameter displays must be arranged and isolated from each other so that any failure or malfunction that affects the display or accuracy of any propulsion system parameter for one system will not cause the loss of display for the remaining engines or adversely affect the accuracy of any parameter for the remaining engines.

(B) For any propulsion parameter display system, no single failure, or malfunction, or probable combinations of failures, shall result in the loss of display, or in the misleading display, of any propulsion parameter(s) that would jeopardize the continued safe operation of the airplane.

(C) Propulsion system parameters that are not displayed continuously must be displayed automatically when any operating limit is reached or exceeded. The required displays and alerts for each phase of flight and airplane configuration must be provided in a timely manner and in a form that enables the crew to identify and carry out necessary remedial actions.

(D) Propulsion system parameters necessary for safe operation, including engine restart, must be displayed automatically after the loss of normal electrical power."

This Directorate's Transport Standards Staff (ANM-110) is in the process of revising AC 25-11. This process requires inter-directorate coordination and an opportunity for public comments. This process is expected to be completed before the end of 1990. Meanwhile, we recommend application of this criteria in lieu of that contained in paragraph (ix).

ENGINE ROTOR BURST PROTECTION

In response to questions received concerning engine rotor burst protection and related certification aspects, this Directorate offers the following general information:

1. The major considerations for any engine installation is that there must be adequate protection to other engines, fuel systems, control systems, and structures to permit the airplane to continue safe flight and landing <u>following</u> an engine rotor failure (rotor burst) or a fire that may burn through the engine case. From the rotor burst aspect, FAR 25.571(e) states:

"The airplane must be capable of successfully completing a flight during which likely structural damage occurs as a result of; . . .

(2) . . . uncontained fan blade impact,
(3) Uncontained engine failure; or
(4) Uncontained high energy rotating machinery failure."

This requirement is in addition to the engine isolation [FAR 25.903(b)] and hazards protection [FAR 25.903(d)] regulatory requirements. Policy guidance is available in FAA Order 8110.11, dated November 19, 1975; Advisory Circular (AC) 20-128, "Design Considerations for Minimizing Hazards Caused by Uncontained Turbine Engine and Auxiliary Power Unit Rotor and Fan Blade Failures," dated March 9, 1988; and AC 25-8, "Auxiliary Fuel System Installation", dated May 2, 1986.

2. The major technical operational and maintenance concerns associated with a dual twin-pack engine installation is the engine isolation requirements from the electrical and control system aspect and the reduction of hazard from a malfunction or failure. In light of a recent U.S. commercial accident that was apparently caused from an uncontained rotor failure, the Transport Airplane Directorate is reconsidering its previous policies and practices, taking a closer look at the possible hazards from an uncontained engine rotor burst, and may require more conservative compliance methods in the future in order to improve aircraft safety.

3. The advisory circular is a means to provide information, policy, definitions, and interpretation to the public, the applicant, and to other FAA offices. However, not all possible methods of compliance to a regulation are identified in an AC. It is not FAA policy to design an installation nor to limit possible designs. In fact, the FAA's policy is to foster additional methods or ways to safely design an installation. The FAA will evaluate

any installation, whether or not identified within an AC as one method that has been found acceptable, and determine that the safety aspects of the FAR's have been satisfied. It is our hope that AC 20-128 (identified above), will permit an applicant to understand the ramifications of the affects from a rotor burst and to design accordingly. The AC system is not stagnant, and revisions to an AC are often being considered in order to provide the latest information to the user.

4. The most frequent method to demonstrate acceptable compliance to a regulation is either by testing and/or analysis. Testing is usually accomplished within the airplane (like flight testing) or with a model (perhaps a full-scale section). Analysis is accomplished when the required testing may be too hazardous, acceptable analytical methods have been developed for evaluation or the installation is sufficiently similar to another installation that has been demonstrated to have acceptable service experience.

5. There have been many innovative methods proposed to minimize the hazards from an uncontained engine rotor burst and to therefore isolate one engine from another. These include lightweight composite blankets, foam insulation, etc. These proposals must be demonstrated to be safe (e.g., cannot give off poisonous gases, cannot propagate flame, must provide adequate fragment and rotor segment stopping power, cannot be an installation or service hazard, etc). Additional research, to augment or further that which may have been accomplished by the armed forces, would put an applicant a step ahead in the certification process. All planned testing accomplished in order to satisfy a regulatory requirement must be reviewed and approved by the FAA in advance of the test.

6. Although the airplane performance calculations following an engine-out are based on a single engine failure condition, it cannot be assumed that an uncontained engine failure may not cause the adjoining engine to fail unless it can be shown that extra precautions are taken to totally isolate the "twin" siamese engine. The Aircraft Certification Office, Propulsion Branch, that reviews an application, has the responsibility to assure that one engine failure will not cause the failure of the remaining engines in compliance with the regulations.

It should be pointed out that FAR 21.19 requires a new Type Certificate (as opposed to a Supplemental Type Certificate) when a change in the number of engines or rotors is proposed. In addition, the FAA encourages certification to the latest regulatory amendment for proposed major revisions to an aircraft.

EXTENDED RANGE TWIN-ENGINE OPERATIONS (ETOPS)

The following was extracted from remarks delivered by Anthony J. Broderick, Associate Administrator for Regulation and Certification, AVR-1, at ETOPS symposiums held in November 1989 and May 1990:

The criteria for both Advisory Circular (AC) 120-42 and 120-42A were developed through a process of soliciting and coordinating a wide range of viewpoints. I hope you would all agree that this process has served us well in our past efforts and I believe that continuation of this cooperation is absolutely necessary if we are to refine and improve our

ETOPS programs and criteria. That is the way we got where we are today.

AC 120-42A establishes in-service experience requirements for both the airworthiness approval of each specific airframe/engine combination and also for the operational approval of each operator intending to conduct ETOPS with a specific airframe/engine combination. The in-service experience requirements for airworthiness approval are summarized in the AC, which calls for an engine that is a candidate for 120-minute approval to have accumulated 250,000 total hours of operation. In addition, a significant portion of the total hours must be accumulated on the specific airframe which makes up the candidate airframe/engine combination. Prior to consideration for 180-minute approval, a candidate engine/airframe combination must meet the same requirements and, in addition, must have accumulated one year of experience with the fleet which is configured to the FAA-approved ETOPS build standard.

Operational approval requirements are also contained in the AC under "in-service experience." This paragraph states first that operator in-service experience requirements may be increased or decreased following a review by the FAA's Director of Flight Standards on a case-by-case basis. It goes on to state that an operator seeking 120-minute approval should accumulate 12 consecutive months of in-service experience with the specific engine/airframe combination. It further states than an operator requesting 180-minute approval should have accumulated an additional 12 consecutive months of in-service experience in conducting 120-minute extended range operations.

The FAA believes that in-service experience requirements have served us well over the past five years. Airframe/engine combination experience has enabled us to identify and rectify a number of problems prior to approving ETOPS operation. The majority of these problems can be categorized into six basic areas:

- **control systems malfunctions;**
- **crew indicating/alerting system malfunctions;**
- **fuel and lubrication system malfunctions (i.e., fan blades, bearings);**
- **miscellaneous engine build up system malfunctions; and**
- **maintenance implicated problems.**

Now I would like to talk about present and future FAA efforts in regards to approval criteria. The FAA presently has two projects which are being pursued: First, the Engine Certification Directorate has developed a draft of a proposed appendix to AC 120-42A. The purpose of this appendix is to address, and better define, issues which relate to engine maturity and derivative engine criteria. The first draft of this appendix has not yet been formally coordinated, but was briefed at a meeting between the FAA and Joint Airworthiness Authorities held recently in London.

The FAA has been comfortable with the engine in-service experience requirements established in AC 120-42A, but we acknowledge that other authorities are using different criteria. We are willing to explore thoughts and ideas which are different from our own, and I hope we can eliminate – or at least reduce to a very small number – any international differences.

Second, the FAA is also exploring new approaches for operational in-service requirements for operators who wish to gain 180-minute ETOPS authority. As I noted earlier, AC 120-42A requires an operator to obtain 12 consecutive months of ETOPS experience prior to being granted 180-minute authority. The FAA, the Air Transport Association, and the pilot groups have been working on a draft appendix to AC 120-42A which sets guidelines for obtaining this experience on non-ETOPS routes. The proposal calls for the collection of reliability data, such as in-flight shutdowns, on approximately 1,000 flights over "simulated" ETOPS routes. (Note that, if we get a lot of shutdowns on those 1,000 flights, I wouldn't count on prompt ETOPS approval!) The concept also calls for a program to familiarize the operator with flight planning factors in the proposed actual area of operation, such as terminal and enroute weather and facility information. And finally, the proposal calls for a series of demonstration flights in the actual area of operations as the final phase in showing 180-minute ETOPS capability.

So, the question of the day is: *"Is it possible to do ETOPS out-of-the-box?"* It very well may be, but the track record for new engines doesn't make that obvious. Not too long ago, a major American manufacturer told FAA that their new large turbofan engine, in the 35 to 40 thousand pound thrust class, was intended to be ready for ETOPS from the very beginning. We read them loud and clear, but the performance of this new design simply did not live up to expectations. It was nothing big or mysterious – just a whole lot of "infant mortality" problems – little things. But they didn't demonstrate to us what they had intended. Another U.S. manufacturer came closer with its new engine, with a very low initial shutdown rate. But an intolerance for water has caused us to remove it from ETOPS. Most recently, a derivative of that engine turned out to have a serious problem when "pushed" to higher RPM for a thrust increase – a serious problem which resulted in swirl incidents and, perhaps, even led to an accident.

All of that is not to say you cannot do ETOPS out of the box. It's just to point out that even our recent track record doesn't warm a regulator's heart. Maybe that helps explain why my propulsion engineering colleagues here develop ashen faces, and shake their heads in amazement, when I raise the subject with the folks that actually have to certify the machine.

But just because we haven't yet seen how to do it, or proven that it can be done, shouldn't stop us from trying. All of us, working together, may be able to achieve that milestone sooner than we think. If we can't convince ourselves we know how to do it the first time around, maybe the second time we will succeed.

I hope that a byproduct of our efforts will be to eliminate nation-to-nation variations in the standards and practices for ETOPS. To say the least, these objectives provide us with interesting challenges in the months ahead.

ETOPS is, in my opinion one of two programs in recent times which have significantly improved aviation safety. The other program deals with aging aircraft. What these two programs have incommon is an international government-industry approach to problem solving, in a continuing and very open exchange of ideas and concepts. From this cooperation – among airlines, manufacturers, labor unions, and regulatory authorities – comes an array of problems and the development of early and effective solutions. The price of this cooperation, as my people and many of you continue to point out, is the need to commit resources – early and often...

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NOTE: The following represents ETOPS approvals thathave been granted for U.S. carriers, and ETOPS approval status as of April 1990:

75-MINUTE			
Airline	Model	Engine	Date Approved
Pan Am	A300-B4	CF6-50	Late 1985
Eastern	A300-B4	CF6-50	April 1981
American	A300-600	CF6-80C2	October 1981
Pan Am	A310-300	PW4000	TBD

120-MINUTE			
Year	Model	Engine	Month Approved
1985	B737-200	JTD8D-9/-9A	Dec.
	B767-200	JT9D-7R4D/E	May
	B767-200	CF6-80/-80A	August
1986	B737-200	JT8D-15/-15A	Dec.
	B737-200	JT8D-17/-17A	Dec.
	B737-300*	CFM56-3D	Nov.
	B757-200	RB211-535E4	Dec.
*Now rescinded per airworthiness directive			
1987	A310-200	JT9D-7R4	May
1988	B767-300	CF6-80C2	May
1990	A300-600	CF6-80C2	April
	A310-300	PW4000	April
	B757-200	PW2037/2040	March
	B767-300	PW4000	April

180-MINUTE			
1989	B767-300	CF6-80A /-80C2	April
1990	B767-200	JT9D-7R4D/E	April
	A300-600	CF6-80C2	April

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"SNAPSHOT" COMPLETED EARLY

On September 21, 1987, then-Administrator T. Allan McArtor announced that, as part of his IMPACT '88 Program, the Aircraft Certification Service (AIR) would conduct a national Safety Inspection of FAA production approval holders and their suppliers both here and abroad. The inspection program was dubbed "Operation *SNAP-*

SHOT." (See Northwest Mountain Region Designee Newsletter, Edition 7, dated June 1, 1988.)

Originally, 160 inspections of aircraft, products, and parts manufacturing facilities were scheduled. The first inspection took place in November 1987 and the last inspection was completed in January 1989. The 88 completed inspections included 32 production approval holders and 56 suppliers (14 of these inspections took place in foreign countries). The rest of the scheduled inspections were cancelled because little new information was being collected by the additional inspections.

The inspections sampled all categories of production approval holders and their related suppliers. The inspection teams reviewed a variety of manufacturing product lines: airplanes, helicopters, engines, propellers, landing gear, forgings, raw materials, and electronic/avionic components.

Operation SNAPSHOT did identify weaknesses in certain procedures in aircraft manufacturing and in FAA surveillance. An ever-widening gap between the FAA and industry in understanding state-of-the-art technologies, inadequate manufacturer control of suppliers, noncompliance with FAR requirements, and industry perceptions that FAA certificate management lacked standardization, highlighted the need for change. The large number of manufacturers and suppliers – some 1,357 certificated production approval holders and 10,000 suppliers – supervised by AIR's comparatively small number of aviation safety inspectors and aerospace engineers also caused concern.

This programs findings will be used to help formulate other AIR certificate management programs in the future – programs that will strive to promote regulatory compliance by production approval holders and to improve relationships between industry and the FAA.

"SYNTHETIC VISION": A CONCEPT FOR THE 90'S

Synthetic Vision sounds like a project on the cutting edge of new technology. . .and it is. Indeed, it may very well be the aviation concept of the mid-1990's.

Synthetic Vision is promising because it will allow pilots to land safely in fog and other low-visibility conditions. The new concept will give them a reliable image of the runway environment on a heads-up display (HUD) located where pilots need it; that is, directly between the pilot and the window, exactly where it would be if the runway could be seen with the naked eye.

The technology would help to return control of the aircraft to pilots, giving them additional tools to overcome bad weather. Safety also would be enhanced by reducing cockpit workload during the most critical phase of flight when adverse weather conditions are most likely to contribute to an accident.

Innovative millimeter-wave sensors with weather penetration ability are being developed for Synthetic Vision. These sensors will provide the image of the runway area from about two miles out for the final phase of landing rollout and taxi. Existing forward looking infrared (FLIR) sensors will also be used to augment the visual picture at night in good weather.

In addition to the runway image, other data projected on the HUD include altitude, airspeed, pitch, heading, and a velocity vector derived from the Inertial Navigation System to show the pilot exactly where the aircraft is pointing. Ideally, it will present all the information needed to make a safe landing in Category III (most restrictive) conditions.

The benefits of an operational Synthetic Vision system go far beyond safety. The system will extend aircraft operations in extreme low-ceiling and low-visibility conditions and provide access to many airfields now available only in good weather. By presenting a real image of the runway complex, the decision to land can be made by the pilot from onboard systems complemented by existing ground navigation and approach aids, such as instrument landing systems ILS), microwave landing systems (MLS), or global approach systems (GPS).

The Synthetic Vision project is a joint FAA/DOD/industry effort that began at the direction of former FAA Administrator T. Allan McArtor in July 1988. FAA's leadership in the project is provided by the Advanced System Design Service through its Engineering Field Office at the NASA Langley Research Center, Hampton, Virginia.

A technical team provides the expertise needed in the areas of sensors, image processing, and systems integration. The team continues to build on work previously accomplished by the Air Force Flight Dynamics Laboratory and is using its contracting capabilities to launch the competitive development of the millimeter-wave sensors.

The initial proposal evaluation phase ended in late 1989, and contracts are to be awarded early this year. Sensors will be available by late 1990 for testing in a tower facility at Wright-Patterson Air Force Base in Ohio, as well as on aircraft.

A certification study team composed of FAA and industry representatives was formed in March 1989 to identify the key issues of certification and to formulate a certification methodology. Issues such as reliability and performance are being analyzed using flight test data from a flying laboratory and simulator test results provided by industry. Studies will address cost-performance tradeoffs, workload, pilot/vehicle interface, and display and imaging characteristics.

After defining the critical issues and providing a clearly developed methodology which, if followed, would support certification, the product of this work will probably be a draft advisory circular for use in the certification of Synthetic Vision.

In 1990, a systems integration contract will be awarded to develop the necessary image enhancement techniques and to develop and integrate the functional prototype sensor, display system, computers, and electronics on an executive-class aircraft. Completion of the flight demonstration and performance evaluation is expected in 1992.

In summary, the Synthetic Vision project capitalizes on new technology, innovative contracting, industrial investment, interagency cooperation, and pervious experience of similar programs to demonstrate and document the extent to which imaging systems can be used as a cost-effective means for aircraft landings in low-ceiling and visual range. It is a near-term, achievable, and positive step to help meet the challenges of a safer, more efficient National Airspace System. It promises to be a major contributor in achieving the elusive goal of all-weather aircraft operations.

REPORTS AND OTHER INFORMATION AVAILABLE

FUEL TANK INSTALLATIONS UNDER CRASH CONDITIONS

Report DOT/FAA/CT-88/24, "Investigation of Transport Airplane Fuselage Fuel Tank Installations Under Crash Conditions," dated July 1989, describes the initial follow-on effort to a previous study described in "Fuel Containment Concepts – Transport Category Airplanes," which concluded that a short term test program involving fuselage-mounted fuel tank installations be developed and conducted.

Three contemporary fuel tank installation configurations investigated in this study include:

- **conformable tank containing a bladder and supported within a dedicated structure;**
- **double wall cylindrical strap in auxiliary tank;**
- **bladder cells fitted in the lower fuselage.**

This report reviews existing crash design criteria, as well as current proposals which could affect fuel tank installations. The performance of a fuselage-mounted tank when subjected to dynamic loads is evaluated. A total of 21 cases were analyzed, including 12 vertical impacts and 9 longitudinal pulse conditions and/or configurations. The analytical models included 120-inch sections, 300-inch segments, and full airplane representations. Results in the form of floor and fuel tank accelerations, floor and fuel tank attachment loads, and fuselage crush were obtained.

Two test conditions are proposed to represent conditions that best meet the crash design criteria developed in a previous FAA-sponsored parametric study, as well as to recognize realistic structures and tests that can be run. A preliminary test plan is included.

ENERGY EFFICIENT ENGINE

A NASA-sponsored Energy Efficient Engine Program was conducted by Pratt & Whitney (P&W) to develop and demonstrate an advanced technology base for a new generation of fuel-efficient, turbofan engines for use in future commercial transport aircraft. The report entitled, "Energy Efficient Engine Final Report," NASA Contractor Report 182300, dated December 1989, summarizes the results of: (1) the component technology efforts, and (2) the flight propulsion system design and performance/cost analyses. The entire effort was designed to attain the NASA-established goals, relative to the P&W JT9D-7A engine, as follows:

- **12 percent minimum reduction in cruise thrust specific fuel consumption;**
- **5 percent minimum reduction in direct operating cost;**
- **50 percent less performance deterioration; and**

- **FAR Part 36 (1978) noise rules and EPA-proposed 1981 exhaust emission standards.**

The Energy Efficient Engine Program included the following tasks designed to meet these objectives:

TASK 1. Flight Propulsion System Analysis, Design, and Integration: Under this task, the design and evaluation of the flight propulsion system was initially conducted based on the results of the Energy Efficient Engine Preliminary Design and Integration studies, and then updated at intervals throughout the program.

TASK 2. Component Analysis, Design, and Development: Under this task, component analysis and design, selected component testing, and supporting technology efforts were conducted.

TASK 3. Experimental Core Design, Fabrication, and Testing: Under this task, the design of the experimental core was initiated.

TASK 4. Integrated Core/Low Spool Design, Fabrication, and Testing: Under this task, a detailed design of the integrated core/low spool was completed.

TASK 5. Program Management and Reporting: Under this task, project management and report preparation was concluded.

Copies of the reports cited above may be obtained from the U.S. Department of Commerce, National Technical Information Service, 5282 Port Royal Road, Springfield, Virginia 22161.

TECHNICAL STANDARD ORDERS (TSO)

TSO-C2d, *Airspeed Instruments,* dated June 14, 1989: Prescribes the minimum performance standard that airspeed instruments must meet in order to be identified with the applicable TSO marking. New models of airspeed instruments that are to be so identified and that are manufactured on or after the date of this TSO must meet the standards set forth in the Society of Automotive Engineers (SAE) Aerospace Standard 8019, "Airspeed Instruments," dated March 30, 1981, as amended and supplemented by this TSO.

TSO-C3d, *Turn and Slip Instrument,* dated June 14, 1989: Prescribes the minimum performance standard that turn and slip instruments must meet in order to be identified with the applicable TSO marking. New models of these instruments that are to be so identified and that are manufactured on or after the date of this TSO must meet the standards set forth in SAE Aerospace Standard 8004, "Minimum Performance Standard for Turn and Slip Instrument," dated September 1975, as amended and supplemented by this TSO.

TSO-C5e, *Direction Instrument, Non-Magnetic (Gyroscopically Stabilized),* dated June 14, 1989: Prescribes the minimum performance standard that direction instruments, non-magnetic type (gyroscopically stabilized), must meet in order to be identified with the applicable TSO marking. New models of these instruments that are to be so identified and that are manufactured on or after the date of this TSO must meet the standards set forth in SAE Aerospace Standard 8021, "Direction Instrument, Non-Magnetic (Gyroscopically Stabilized)," dated

March 16, 1981, as amended and supplemented by this TSO.

TSO-C6d, *Direction Instrument, Magnetic (Gyroscopically Stabilized),* dated June 14, 1989: Prescribes the minimum performance standards identified in SAE Aerospace Standard AS 8013, "Direction Instrument, Magnetic (Gyroscopically Stabilized)," dated June 1983, as amended and supplemented by this TSO. Environmental conditions and test procedures have been prescribed by RTCA DO-160B. RTCA DO-178A has been defined for the use of software verification.

TSO-C7d, *Direction Instrument, Magnetic Non-Stabilized Type (Magnetic Compass),* dated June 14, 1989: Prescribes the minimum performance standard that direction instruments, magnetic non-stabilized type, must meet in order to be identified with the applicable TSO marking. New models of these types of direction instruments that are to be so identified and that are manufactured on or after the date of this TSO must meet the standards set forth in SAE Aerospace Standard 398A, "Direction Instrument, Magnetic Non-Stabilized Type (Magnetic Compass)," dated October 1984.

TSO-C14b, *Aircraft Fabric, Intermediate Grade,* dated February 15, 1990: Prescribes the minimum performance standards identified in SAE Aerospace Material Specification (AMS) Document No. AMS 3804C, "Cloth, Airplane, Cotton, Mercerized 65 lb. (290N) Breaking Strength," dated January 1, 1984, with exceptions covered in the TSO.

TSO-C15d, *Aircraft Fabric Grade A,* dated February 26, 1990: Prescribes the minimum performance standards set forth in SAE Aerospace Material Specification (AMS) Document No. AMS 3806D, "Cloth, Airplane, Cotton, Mercerized 80 lb. (355N) Breaking Strength," dated April 15, 1980, with exceptions.

TSO-C21b, *Aircraft Turnbuckle Assemblies and/or Turnbuckle Safetying Devices,* dated March 16, 1989: Prescribes the minimum performance standards set forth in Section 3 and 4 of Military Specification MIL-T-8878C, "Turnbuckles, Positive Safetying," dated October 8, 1985, with exceptions.

TSO-C30c, *Aircraft Position Lights,* dated May 12, 1989: Prescribes the minimum performance standards identified in SAE Aerospace Standard 8037, "Minimum Performance Standard for Aircraft Position Lights," dated January 1986. Environmental conditions and test procedures have been prescribed by RTCA DO-160B.

TSO-C64a, *Oxygen Mask Assembly, Continuous Flow, Passenger,* dated August 25, 1989: Prescribes the minimum performance standards that devices must meet in order to be identified with the applicable TSO marking. New models that are to be so identified and that are manufactured on or after the date of this TSO, must meet the standards set forth in SAE Aerospace Standards 8025, "Passenger Oxygen Mask," dated February 24, 1988.

TSO-C116, *Crewmember Protective Breathing Equipment:* Prescribes the minimum performance standards set forth in Appendix 1, of the "Federal Aviation Administration Standard for Crewmember Protective Breathing Equipment." Environmental conditions and test procedures have been prescribed by RTCA DO-160B.

TSO-C121, *Underwater Locating Devices (Acoustic)(Self-Powered):* Prescribes the minimum performance standards set forth in SAE Aerospace Standard 8045, "Minimum Performance Standard for Underwater Locating Devices (Acoustic)(Self-Powered)," dated May 16, 1988, Sections 4 through 7. Environmental conditions and test procedures have been prescribed by RTCA DO-160B.

To obtain a copy of any of the TSO's listed above, write to:

Federal Aviation Administration
Aircraft Certification Service
Aircraft Engineering Division (AIR-100)
800 Independence Avenue, S.W.
Washington, D.C. 20591

ADVISORY CIRCULARS

AC 25-15: *Approval of Flight Management Systems in Transport Category Airplanes.* This AC was issued on November 20, 1989, and outlines a method of compliance with the rules for airworthiness approval of flight management systems on transports which process data derived from a relatively large number of onboard performance and navigation sensors. Guidance contained in this AC includes considerations of system integrity, navigation, performance management, autothrottle systems, takeoff performance monitor, fuel state, data link, and software based systems.

AC 25.562-1*:* *Dynamic Evaluation of Transport Airplane Seats.* This AC was issued on March 6, 1990, and provides guidance for demonstrating compliance with the dynamic seat rule (Amendment 25-64; May 1988). Guidance contained in this AC includes a description of the test facilities, requirements of the test instrumentation, installation of the seat and dummy in the test fixture, the allowable permanent set deformation, a description of the anthropomorphic test dummy, procedures for assessing the injury criteria, and procedures for installing the seat in the airplane.

AC 20-135: *Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria.* This AC was issued on February 6, 1990, and contains guidance for demonstrating compliance with the powerplant fire protection requirements of the FAR. Included in this document are methods for fire testing of materials and components used in the propulsion engines and APU installations and in areas adjacent to designated fire zones.

PROPOSED ADVISORY CIRCULARS

AC 25-XX: *Pilot Compartment View Design Considerations.* On April 30, 1990, a notice was published in the Federal Register inviting public comment on this proposed AC, which provides guidance concerning the properties of transparent materials necessary to assure adequate visibility from the flight deck. The period for public comment closes August 29, 1990.

RULEMAKING

AMENDMENTS

Amendment 36-17: *Limits on the Growth of Noise from Certain Airplanes and Airplane*

Types, effective August 14, 1989, revises noise certification standards to ensure that aircraft certification within certain noise level groups, or "Stages," remain within those stages. This rule applies to large transport category aircraft and to turbojet-powered aircraft regardless of category. It prohibits modification of individual airplanes and whole airplane types which would result in increased noise beyond the limits of an airplane's certified stage. While the rule does not restrict airplane changes that result in decreased noise, it does prohibit any re-modification of an airplane which would return it to its original noise level stage.

PROPOSED RULES

Notice 90-3: *Airplane Jacking and Tie-Down Provisions,* was issued on January 25, 1990. This notice proposes to amend the airworthiness standards for transport airplanes to add new design standards for airplane jacking and tie-down provisions. This proposal is intended to provide protection of the airplane primary structure during wind gust conditions during jacking operations and while tied down. Notice 90-3 was published in the Federal Register on February 9, 1990. The public comment period closes August 8, 1990.

Notice 90-11: *Emergency Locator Transmitters,* was issued on April 2, 1990. This notice proposes to require installation of an improved emergency locator transmitter (ELT) that meets the requirements of the revised Technical Standard Order (TSO) TSO-C91a on U.S.-registered aircraft, and terminate ELT's authorized under the original TSO-C91. This proposal is prompted by unsatisfactory performance experienced with ELT's that are manufactured under the original TSO and related to safety recommendations by the National Transportation Safety Board and search and rescue community. Although most of the unsatisfactory field experience has been with automatic ELT's, the FAA also proposes improved standards for survival ELT's. Notice 90-11 was published in the Federal Register on April 2, 1990. The public comment period closes July 31, 1990.

SUMMARY OF FAR PART 25 AMENDMENTS

Many times, articles in this Newsletter refer to amendments of FAR Part 25, "Airworthiness Standards: Transport Category Airplanes." For your information and future reference, the following list identifies what subject each amendment covers and its date of issuance.

Part 25: Effective February 1, 1965; Basic issuance

Amdt. 25-1: Effective June 7, 1965; Improved emergency evacuation procedures and equipment for passenger-carrying aircraft

Amdt. 25-2: Effective March 26, 1965; Cockpit voice recorders

Amdt. 25-3: Effective May 28, 1965; Minimum flight crewmembers

Amdt. 25-4: Effective April 30, 1965; Transfers requirement for lockable flight door to Part 121

Amdt. 25-5: Effective July 29, 1965; Altimeter system requirements

Amdt. 25-6: Effective August 1, 1965; Limited weight credit for standby power

Amdt. 25-7: Effective November 14, 1965; Stability and stalling characteristics

Amdt. 25-8: Effective February 5, 1966; Flight recorders

Amdt. 25-9: Effective June 30, 1966; Miscellaneous amendments

Amdt. 25-10: Effective October 10, 1966; Sonic fatigue requirments

Amdt. 25-11: Effective June 4, 1967; Miscellaneous propulsion system design requirements

Amdt. 25-12: Effective August 1, 1967; Altimeter system requirements

Amdt. 25-13: Effective July 27, 1967; Hydraulic system requirements

Amdt. 25-14: Effective Sept. 10, 1967; Fuel system lightning protection

Amdt. 25-15: Effective October 15, 1967; Crashworthiness and passenger evacuation standards

Amdt. 25-16: Effective October 6, 1967; Cockpit voice recorders

Amdt. 25-17: Effective June 20, 1968; Crashworthiness and passenger evacuation standards

Amdt. 25-18: Effective Sept. 29, 1968; Fuel jettisoning systems

Amdt. 25-19: Effective November 16, 1968; Relaxed fire standards for wet sump reciprocating engines

Amdt. 25-20: Effective April 23, 1969; Crashworthiness and passenger evacuation standards

Amdt. 25-21: Effective February 5, 1970; Maintenance manual requirements

Amdt. 25-22: Effective February 5, 1970; Additional attitude instrument in large airplanes

Amdt. 25-23: Effective May 8, 1970; Miscellaneous type certification standards.

Amdt. 25-24: Effective May 9, 1970; Attitude instrument in lieu of rate-of-turn indicator.

Amdt. 25-25: Effective Sept. 18, 1970; Additional flight recorder data and other requirements.

Amdt. 25-26: Effective April 23, 1971; Fire detectors and engine power response

Amdt. 25-27: Effective August 11, 1971; Anticollision lights

Amdt. 25-28: Effective Sept. 25, 1971; Emergency slide lighting

Amdt. 25-29: Effective October 21, 1971; Emergency locator transmitters

Amdt. 25-30: Effective November 5, 1971; Position light system dihedral

Amdt. 25-31: Effective January 10, 1972; Flight recorders

Amdt. 25-32: Effective May 1, 1972; Crashworthiness and passenger evacuation standards

Amdt. 25-33: Effective October 21, 1972; Emergency exit arrangement

Amdt. 25-34: Effective December 31, 1972; Rear exit security

Amdt. 25-35: Effective March 1, 1974; Engine rotor unbalance indicator

Amdt. 25-36: Effective October 31, 1974; Minor propulsion system changes

Amdt. 25-37: Effective February 14, 1975; Nonsubstantive clarifications.

Amdt. 25-38: Effective February 1, 1977; Airworthiness review Amendment 3, miscellaneous amendents

Amdt. 25-39: Effective February 10, 1977; Increase maximum passenger seating capacity of Type A exits to 110

Amdt. 25-40: Effective May 2, 1977; Airworthiness review Amendment 4, powerplant amendments

Admt. 25-41: Effective Sept. 1, 1977; Airworthiness review Amendment 50, equipment and systems amendments

Amdt. 25-42: Effective March 1, 1978; Airworthiness review Amendment 6, flight amendments

Amdt. 25-43: Effective April 12, 1978; Pitot heat indication systems

Amdt. 25-44: Effective December 5, 1978; Operations review Amendment 6, related airworthiness standards

Amdt. 25-45: Effective December 1, 1978; Fatigue review amendments

Amdt. 25-46: Effective December 1, 1978; Airworthiness review Amendment 7, airframe amendments

Amdt. 25-47: Effective December 24, 1979; Operations review Amendment 10, related airworthiness standards

Amdt. 25-48: Effective December 31, 1979; Wheels and wheel-brake assemblies

Amdt. 25-49: Effective December 31, 1979; Tires

Amdt. 25-50: Effective February 20, 1980; Cabin ozone contamination

Amdt. 25-51: Effective March 6, 1980; Airworthiness review Amendment 8, cabin safety and flight attendant

Amdt. 25-52: Effective Sept. 9, 1980; Technical standard order program

Amdt. 25-53: Effective August 31, 1980; Operations review Amendment 8, related airworthiness standards

Amdt. 25-54: Effective October 14, 1980; Airworthiness review Amendment 8A, miscellaneous amendments

Amdt. 25-55: Effective April 28, 1982; Miscellaneous amendments

Amdt. 25-56: Effective January 31, 1983; Relief from certain ozone requirements

Amdt. 25-57: Effective March 26, 1984; Aircraft engine review; related installation requirements.

Amdt. 25-58: Effective November 26, 1984; Floor proximity emergency escape path marking

Amdt. 25-59: Effective November 26, 1984; Flammability of seat cushions

Amdt. 25-60: Effective June 16, 1986; Cargo or baggage compartment liners

Amdt. 25-61: Effective August 20, 1986; Flammability of interior materials

Amdt. 25-62: Effective December 9, 1987; Automatic takeoff thrust control system

Amdt. 25-63: Effective May 6, 1988; Noise certification (conforming change)

Amdt. 25-64: Effective June 16, 1988; Seat safety standards

Amdt. 25-65: Effective October 11, 1988; Cockpit voice and flight recorders

Amdt. 25-66: Effective Sept. 26, 1988; Refinements; flammability of interior materials

Amdt. 25-67: Effective July 24, 1989; Location of emergency exits (60-feet)

Amdt. 25-68: Effective August 18, 1990; Nonsubstantive conforming change (delayed effectivity)

Amdt. 25-69: Effective October 30, 1989; Fuel tank access covers

Amdt. 25-70: Effective November 27, 1989; Independent power source for public address system

Amdt. 25-71: Effective May 10, 1990; Pressurized cabins and compartments.

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NOTE FROM THE EDITOR

If you would like a copy of any of the previous editions of the Transport Airplane Directorate (Northwest Mountain Region) Designee Newsletter, or if you are a Designee who would like to have your name added to our mailing list, please submit your request to:

Federal Aviation Administration
Transport Airplane Directorate
Aircraft Certification Service
ATTN: Editor (DeMarco), ANM-103
17900 Pacific Highway South
C-68966
Seattle, Washington 98168

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